March, 2007

The Perils of a Half-Built Bridge: Risk Perception, Shifting Majorities, and the Nuclear Power Debate

Amanda Leiter, Georgetown University Law Center

Available at: https://works.bepress.com/amanda_leiter/1/
THE PERILS OF A HALF-BUILT BRIDGE: RISK PERCEPTION, SHIFTING MAJORITIES, AND THE NUCLEAR POWER DEBATE

Amanda Leiter*

Much of the risk perception literature relies on the important but unstated assumption that manipulating public opinion to conform to scientific assessments of risk could help the public and, in turn, policymakers make better decisions about whether and how to regulate.\(^1\) This paper argues that the assumption fails in the context of certain “multilayered” risks, or risks that pose tiered policy choices – not just whether to regulate in the first instance, but how to respond to derivative risks arising from the first set of regulatory changes. Examining the debate about the role of nuclear power in the United States’ approach to climate change, the paper observes that first- and second-tier risks often differ in character, or require different types of regulatory solution (market-based versus command-and-control). Due to these variations, the public may hold starkly different views about regulation of each tier, and those views may be differently “sticky” – that is, differently susceptible to persuasion.

In the context of the nuclear power debate, this tiering of opinion has perverse implications. The first-tier risks of nuclear power are those associated with individual reactors, including the risks of accident or terrorist attack; the second-tier risks are those associated with mining, transport, processing, storage, and disposal of radioactive materials. Recent work asserts that despite entrenched public fear of nuclear power, it may be possible to induce people to support construction of low-emissions reactors as a strategy for mitigating climate change. But even if policymakers could employ the risk education strategies discussed in the literature to shift public opinion in favor of economic incentives for nuclear reactor development, there is no reason to think such strategies would be equally effective at changing attitudes toward second-tier

* Visiting Associate Professor at Georgetown University Law Center. Many thanks to Donald Braman, Peter Byrne, Bonnie Cohen, Louis Cohen, Heather Elliott, Lee Anne Fennell, Geoffrey Fettus, Steven P. Goldberg, Lisa Heinzerling, Dan M. Kahan, Gregory Klass, Richard Lazarus, David Luban, John Mikhail, Sanju Misra, Jon Palfreman, Peter B. Rutledge, Sambhav Sankar, Michael Seidman, Philip G. Schrag, Peter Strauss, Alexander Volokh, John Walke, David Zaring, the secret DC writers group, the GULC Associate Professors group, and students in the 2006 GULC Environmental Workshop for good ideas and hard questions, and to Faith Livermore for excellent research assistance.

\(^1\) E.g., Dan M. Kahan, Paul Slovic, Donald Braman & John Gastil, *Fear of Democracy: A Cultural Evaluation of Sunstein on Risk*, 119 HARV. L. REV. 1071, 1072 (2006) (hereinafter “Fear of Democracy”) (“Risk perception scholars are not of one mind about the prospects for making public opinion conform to the best available scientific information on risk. But no one who aspires to devise procedures that make democratic policymaking responsive to such information can hope to succeed without availing herself of the insights this field has to offer.”).
risks and the command-and-control regulations necessary to address them. To the contrary, many people would likely continue to oppose certain types of government action on these latter problems, even assuming the complete success of the hypothesized first-tier education strategy. As a result, the United States could find itself with a thriving nuclear power sector, but without the political will to address the grave collateral risks.

These observations lead to two conclusions, one related to the nuclear power example, and one to risk regulation more broadly. First, differently sticky public attitudes toward first- and second-tier nuclear risks and their regulatory solutions may defeat any effort to respond to climate change by significantly and safely increasing U.S. reliance on nuclear power. Second, efforts to change public risk perceptions may not advance a regulatory agenda, and may even prove counterproductive. Specifically, where multiple risk layers exist, a successful first-tier education effort and consequent policy changes could create or expose second-tier risks that defy regulatory solution, leaving policymakers stranded at the abrupt and unexpected end of a half-built bridge. Depending on the gravity of the second-tier risks, this regulatory dead end could be one that neither policymakers nor the public would have chosen ex ante.

I. Introduction ................................................................. 3
II. Models of Public Risk Perception ...................................... 10
   A. Background .................................................................. 10
   B. Why Lay and Expert Opinions Differ ................................. 11
      1. Overview ................................................................. 11
      2. The Bounded Rationality Model ................................... 13
      3. The Cultural Cognition Model ..................................... 16
III. Risk Perception and the Nuclear Power Debate .................. 19
   A. The Nuclear Power Example .......................................... 20
      1. Scientific certainty about the effects of climate change ...... 21
      2. Nuclear power as part of the solution ........................... 23
      3. Scale of the necessary investment in nuclear power .......... 24
      4. Economic incentives to boost the nuclear sector ............. 28
      5. Risks and possible regulatory reforms ......................... 30
         a) Reactor safety ..................................................... 30
         b) Proliferation ...................................................... 32
         c) Waste .............................................................. 33
         d) Regulatory reforms to address these risks ................ 35
   B. We Can’t Get There from Here ....................................... 36
      1. Simple failure ........................................................ 37
      2. Partial success ..................................................... 38
IV. Lessons from the Nuclear Power Debate .......................... 41
V. Conclusion ...................................................................... 45
I. Introduction

In the last few decades, social scientists and behavioral economists have made considerable progress in understanding public attitudes toward environmental and health risks, and explaining the persistent split between experts’ and ordinary people’s perceptions of such risks. To date, much of the research has focused on the biases and mental rules-of-thumb (or “heuristics”) that underlie this split. Studies suggest, for example, that people underestimate the risks of beneficial activities, and of activities they undertake voluntarily. In contrast, they overestimate risks imposed involuntarily, and risks associated with activities of which they normatively disapprove. Also, unsurprisingly, people fear risks associated with vividly documented catastrophes far more than equally significant risks that have not recently made the front pages.

Most scholars now agree about the effects of these biases and heuristics, though they debate whether such mental shortcuts are best understood as limits – “bounds” – on people’s reason, or instead as reflections of individuals’ cultural identities. The former view, termed

---


4 See, e.g., Paul Slovic, Howard Kunreuther & Gilbert F. White, Decision Processes, Rationality and Adjustment to Natural Hazards 5, in Perception of Risk, supra (“[T]he public will accept risks from voluntary activities (such as skiing) that are roughly 1000 times as great as it would tolerate from involuntary risks (such as food preservatives) that provide the same level of benefit.”); Lisa Heinzerling, Political Science, 62 U CHI L. REV. 449, 470-72 (1995) (reviewing Stephen Breyer, BREAKING THE VICIOUS CIRCLE (1993)).

5 See, e.g., Slovic, Kunreuther, & White, supra; Heinzerling, supra.


9 See Misfearing, supra note 6, at 1111-12 (“People should be regarded as boundedly rational weighers.”).

10 Fear of Democracy, supra note 1, at 1072 (reviewing LAWS OF FEAR, supra note 7, and arguing that the book ignores “one of the most important recent advances in the science of risk perception” – the way that “cultural worldviews permeate all of the mechanisms through which individuals apprehend risk”).

DRAFT page 3 of 46
“bounded rationality,” conceives of individuals as rational evaluators of risk whose estimations are skewed by perceptual and cognitive biases, but not (in the first instance, at least) by “culture.”11 In contrast, advocates of the “cultural cognition” model assert that “cultural worldviews permeate all of the mechanisms through which individuals apprehend risk, including their emotional appraisals of putatively dangerous activities, their comprehension and retention of empirical information, and their disposition to trust competing sources of risk information.”12

Armed with this basic (if still disputed) understanding of what drives public attitudes toward risks, policymakers are now positioned to address a more prescriptive set of questions, all of which fall under a single broad heading: “How and how much”13 should government respond to arguably-misplaced public fear? For example, should regulators take a “technocrat[ic]” approach, ignoring “public irrationality … and … respond[ing] to fear if and to the extent that it is anchored in reality”?14 Should they instead adopt a “populist” approach and “respond to public concerns, simply because they are public concerns”?15 Or is there a middle ground? Can regulators devise strategies to bring the public’s perceptions closer in line with the experts’ calculations, and then regulate whatever risks the public continues to fear? Does the “right” type and level of regulation16 depend on the “extent of the fear and the cost of the response”?17

This paper contends that one cannot begin to answer these prescriptive questions without looking closely at the nature and structure of the particular risks at issue in any given regulatory debate. To make this point, the paper considers a high-profile contemporary issue18 —
whether the United States should promote nuclear power as a substantial piece of the country’s climate change strategy.

In brief, the terms of this debate are as follows: Nuclear industry proponents claim that, in light of the increasing scientific certainty that climate change poses a real and substantial threat to human health and welfare, the United States should promote rapid and significant growth of the nuclear sector. They point out that nuclear plants do not burn fuel and therefore emit no combustion byproducts like carbon dioxide (one of the so-called greenhouse gases most responsible for climate change). Indeed, even if one takes uranium mining, transport, processing, storage, and disposal into account, most analysts agree that nuclear has greenhouse gas advantages over energy sources like coal and natural gas, and is competitive with alternatives like wind power. Industry opponents, on the other hand, argue that nuclear facilities are not cost-effective, and that the dangers of nuclear power – including safety and proliferation risks and radioactive waste generation – outweigh any putative climate change benefits.

This much of the debate has been widely reported, but one further point bears emphasis here. As discussed in section III.A.3 below, scientists who have evaluated the so-called “nuclear option” have concluded that making nuclear power a nonnegligible piece of our climate change strategy would require construction of about ten large nuclear facilities somewhere in the country every year, and a corresponding expansion of uranium exploration, mining, transport, processing, storage, and disposal operations. Thus, the policy question we currently face – and the only question this paper considers – is not the wisdom of constructing a few new nuclear plants somewhere in the

---


20 Brice Smith, INSURMOUNTABLE RISKS: THE DANGER OF USING NUCLEAR POWER TO COMBAT GLOBAL CLIMATE CHANGE, IEER Press 2 & n.15 (2006), at http://www.ieer.org/reports/insurmountablerisks/ (hereinafter “INSURMOUNTABLE RISKS”) ("Compared to the other major energy sources used around the world to generate base load electricity, ... nuclear power plants emit far lower levels of greenhouse gases even when mining, enrichment, and fuel fabrication are taken into consideration."); see also J.L.R. Proops, P.W. Gay, S. Speck, and T. Schroder, The lifetime pollution implications of various types of electricity generation. An input-output analysis, 24 ENERGY POLICY 229-37 (1996).

country over the next few years, but that of amending regulatory regimes to promote historically unprecedented expansion of the sector as a response to climate change.

It should be apparent that, in the current political climate, such a large scale national commitment to nuclear power would be virtually impossible. The question, then, is whether policymakers could increase public acceptance of nuclear energy by educating people about the risks of climate change and about nuclear power’s relative greenhouse gas advantages, and if so, whether that is an advisable approach.

To investigate that question, this paper supposes two alternative risk education strategies, one that attempts to overcome identified “bounds” on lay people’s assessments of risk, and one that learns the lessons of cultural cognition. Both strategies have the same hypothesized aim: to convince the public that the risks of nuclear power are preferable to (or less significant than) those of climate change, and therefore that the United States should wholeheartedly embrace regulatory changes that streamline development of new nuclear facilities to meet our ever-growing energy needs.

Would either campaign succeed? The risk perception literature suggests two possible answers to this question, neither of which is hopeful for the nuclear industry. First, the education strategies might

---

22 That is, the sweeping policy choice is not whether the marginal benefits of constructing one, two, or ten new nuclear plants over the next few decades exceed the marginal costs of that approach, but whether we should, as a Nation, turn to nuclear power as a significant piece of our climate strategy – and make the regulatory changes that such a sweeping shift in energy policy would entail. Although the discussion in this paper has implications for the former choice, the paper itself is directed only at the latter.

23 See, e.g., David Reiner, et al., An International Comparison of Public Attitudes Towards Carbon Capture and Storage Technologies 6 (2006), at http://sequestration.mit.edu/pdf/GHGT8_Reiner.pdf (citing poll results that suggest far less than half of the U.S. public thinks nuclear power should be “use[d] to address global warming”); Eugene A. Rosa, Public Acceptance of Nuclear Power: Déjà vu All Over Again? 30 FORUM ON PHYS., AND SOC. 4 (2001), at http://www.aps.org/units/ffs/newsletters/2001/april/ap5.pdf (discussing poll results from 1999) (“Past accidents, misrepresentations by the nuclear industry …, and a growing mistrust of many institutions, especially institutions associated with nuclear power, such as the DOE, have made the public apprehensive about the technology. And all signs indicate that this apprehension runs deep. On the other hand, Americans support the idea of leaving the nuclear option open, perhaps as a trump card against future energy shortages or as the only demonstrated energy alternative for dealing with global warming. In summary, while the public may support this technology in the future; there is little basis to say that the future is now.”).

24 The relatively new suggestion of “debiasing through law” offers another potential approach, see generally Christine Jolls, Behavioral Law and Economics (2006), at http://ssrn.com/abstract=959177 (summarizing the approach), though it is not immediately obvious how one could employ such strategy in the specific context of nuclear power.

25 Importantly, this paper does not advocate nuclear power and avoids taking a position on the actual sizes of the nuclear and climate change risks because this hypothetical exercise has important implications whatever one’s views about the relative safety of nuclear technology.
simply fail. Take the bounded-rationality campaign. As discussed below, nuclear power embodies many of the traits that engender an instinctive or affective negative response. As a result, campaign subjects might hold tight to their instinctive fears of nuclear technology in spite of their increased analytical understanding of the consequences of a warming planet.

The cultural cognition campaign, too, might fail, because the same cultural “types” that (according to the model) are predisposed to fear climate change are also more likely to fear nuclear power, while the types that are predisposed to support nuclear energy are correspondingly less likely to be convinced that greenhouse gases pose a serious risk. Rather than overcoming cultural differences in perceptions of the two risks, therefore, the campaign could instead drive opposing groups to their corners.

This first outcome – outright failure – conveys a simple lesson: In deciding what to do about risks that the public arguably misfears, regulators must consider the relative stickiness of the public’s attitudes. For risks that trigger few of our innate or cultural biases, the most democratic and cost-effective approach may be to devise procedures to bring public perceptions in line with expert opinion, and then to regulate only as much as the experts advise. For risks that trigger many biases, however, there is reason to suppose any such education effort would fail, leaving regulators to confront squarely the difficult question posed above – how and how much to regulate in the face of contrary public opinion.

The more interesting possible outcome of the hypothesized education strategies, however, is not failure but partial success. Potentially, either

26 See infra at 19.

27 This paper does not attempt to answer this question. In particular, it avoids entering the debate among those who advocate strict adherence to experts’ assessments of which risks are “real,” see, e.g., Steven G. Breyer, BREAKING THE VICIOUS CIRCLE 55 (1993) (“I assume a kind of ‘general will’—a public that ‘really’ wants an overall result” (greater risk reduction at present cost or equal risk reduction at lower cost) “that differs from its substance-specific preferences revealed on particular occasions”), those who acknowledge that even misplaced public fears may exact a cost sufficient to justify regulation, see, e.g., Cass R. Sunstein, Probability Neglect: Emotions, Worst Cases, and Law, 112 YALE L. J. 61, 103-04 (2002); Frank Ackerman & Lisa Heinzerling, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING 135-36 (2004) (hereinafter “PRICELESS”), and those who would give great weight to the many value judgments implicit in public perceptions of risk, see, e.g., Paul Slovic, Trust, Emotion, Sex, Politics and Science: Surveying the Risk-assessment Battlefield 390, 392, in PERCEPTION OF RISK, supra note 3 (“[M]any of the public’s reactions to risk … can be attributed to a sensitivity to the technical, social and psychological qualities of hazards that are not well-modeled in technical risk assessments.”); PRICELESS, supra, at 136, 151 (“When people worry about risks that are unfamiliar, unknown, and potentially catastrophic, they are expressing, in part, a distaste for a special kind of uncertainty: one in which the worst-case harmful potential of a hazard is unknown and unlimited. … The context of risk, the fairness of burdens and benefits—all these characteristics, which are all-important in real decisions, are priceless. They cannot be forgotten in making effective public policy, but they cannot be remembered with a number.”).
strategy could succeed, but only to a point. Subjects could learn to accept some first-tier nuclear power regulations—say, regulations that promote development of new reactors at existing facilities that have been operating safely for years, or that provide tax incentives and liability coverage for development of new facilities.28 These first-tier regulations would allow the nuclear sector to grow, thereby augmenting derivative risks like safety, proliferation, and radioactive waste. But each of these derivative risks would require its own regulatory solutions, ranging from stricter guidelines for terrorism-resistant plant construction to streamlined procedures for siting and licensing of waste facilities.

Individuals who supported the first-tier market-stimulus regulations might feel differently about these equally necessary, second-tier command-and-control regulations. This shift in attitude could result in two ways. First, people who came to see the advantages of nuclear power could prove to have stickier views toward secondary issues like radioactive waste storage and disposal. Whether one subscribes to the bounded rationality or cultural cognition school of risk perception, there is simply no a priori reason to assume a public that learns to accept new nuclear power facilities will inevitably also surrender its fear of and opposition to new waste facilities. At the end of day, the public’s stickier attitudes toward waste issues could well have a perverse effect: Public fear of waste facilities could lead to strong opposition to waste facility siting and development and, down the road, a less satisfactory public response to the waste problem than to the first-order issues related to new power facility construction and operation.

The second possible shift in public attitudes would only result under the cultural cognition model. Proponents of that model argue that one way to overcome public biases is to devise policies that have “cross-cultural” appeal—that is, policies that will garner the support of a coalition of people of diverse cultural persuasions.29 Again, however, the same coalition may not support both market-based regulations to stimulate the nuclear industry and command-and-control regulations to ensure safe handling and disposal of radioactive materials. Quite the reverse: As discussed below, any coalition that supported the former would likely prove unstable when confronted with the latter. Again, the results could well be perverse: The coalition that supported market-based nuclear power incentives could break down when confronted with proposals for top-down regulatory mandates governing plant operation.

28 See Fear of Democracy, supra note 1, at 1097 (suggesting that market solutions soften some cultural cognition barriers to recognition and regulation of environmental problems).

radioactive material handling, and waste storage and disposal, thereby allowing new plants to come online well before any programs are in place to address their second-tier effects.

These observations about the consequences of a hypothetical bounded rationality or cultural cognition risk-education strategy lead to two broader conclusions. First, pragmatically, an honest appraisal of the immense financial and regulatory investment that would be necessary to make nuclear power a significant and safe part of the United States’ climate change strategy suggests that we cannot get there from here. Either the entrenched public fear of nuclear power will prove resistant to even the best education strategies, or – worse – those strategies will engender support for only the first round of necessary regulatory reforms, not the entire suite of reforms necessary to ensure safe growth of the sector. Thus, absent an unusual willingness on the part of political leaders to buck public will, these scenarios suggest that the nuclear industry will either remain moribund (scenario one), or thrive but evade comprehensive regulation (scenario two).

Second, more theoretically, for multilayered risks like nuclear power, one potential cost of any initial regulatory effort is the development or augmentation of derivative risks that require their own round of regulation. The public may prove to have stickier attitudes toward these newly uncovered risk layers than toward the principal risks, stymieing the initial risk-education strategy. Alternatively, the second-tier risks may require different forms of regulatory solutions, thereby destabilizing the (loose) coalition that supported the first round of regulation. Indeed, Madison all but predicted this latter dynamic in Federalist 10, when he advocated a large republic as a means of limiting the power of unruly factions. “To state the Madisonian proposition … broadly, the danger of a stable coalition increases as the size of the political unit decreases because the areas of disagreement become fewer and the divisions in the population consequently become more fundamental and permanent.”

This insight, salutary in the context of factional rebellion, poses a thorny problem for sensible, stepwise regulation of multilayered risks facing large polities.

Thus, to take the important step from theories that identify and characterize risk perception biases to prescriptions for public-education strategies and regulatory responses, one must have a deep and nuanced understanding of the specific risks at issue. Prescriptions based solely on cognitive psychology may produce unexpected outcomes with costs that outweigh any anticipated benefits.

---

30 See, e.g., Note: City Government in the State Courts, 78 HARV. L. REV. 1596, 1597 (1965).
The remainder of this paper puts flesh on these bones. Section II outlines the principal approaches to risk perception discussed in the literature. Section III introduces the nuclear power debate and explores the potential outcomes of hypothesized risk education strategies based on the bounded rationality and cultural cognition models. Finally, section IV extrapolates from this exercise to the broader problem of public attitudes toward layered risks.

II. Models of Public Risk Perception

A. Background

Every day, we confront serious risks and make behavioral or policy choices that affect the magnitude of those risks. On both the individual and public policy levels, some of those choices are easier to make than others. Individual drivers, for example, readily choose to obey (most) red lights, thereby reducing the probability of serious accidents. And policymakers readily choose to require manhole covers, thereby reducing the probability of fatal falls.

But what of the harder choices – those that require significant individual or public expenditures, and those that involve risk-tradeoffs? Many individuals may have a harder time deciding whether it is “worth it” to sell their old car and purchase a new one that meets the latest safety standards, or to get a vaccine that provides some longterm protection but poses a nonzero risk of immediate infection or other side effects. And policymakers, too, may be uncertain whether to require that new car models incorporate an expensive safety device, or to require that all schoolchildren receive a particular live-culture vaccine.

Since the 1970s, these and related questions have stimulated lively debates about whether and when government should regulate risks. Much of the discussion has addressed questions of scientific, economic, and political philosophy: When is it scientifically and economically “worthwhile” to regulate a risk? And what balance should regulators strike between public safety and individual liberty? Not surprisingly, perspectives on these issues vary widely. Along the scientific- and economic-philosophy spectrum, the views range from those who believe that government activities should be strictly cost-justified31 to those who question the use of any form of cost-benefit analysis,32 and those who

31 E.g., W. Kip Viscusi, Monetizing the Benefits of Risk and Environmental Regulation, 33 FORDHAM URBAN L. J. 1003, 1004-05 (2006) (“Because no risk or environmental benefit warrants an infinite expenditure, the practical policy issue is what level of monetary cost is justified to obtain the benefit.”).

32 E.g., PRICELESS, supra note 27, at 9 (“To say that life, health, and nature are priceless is not to say that we should spend an infinite amount of money to protect them. Rather, it is to say that translating life, health, and nature into dollars is not a fruitful way of deciding how much protection to give them. A different way of thinking and deciding about them is required.”)
advocate instead a general “precautionary principle.” The political-philosophy spectrum, on the other hand, extends from those who would limit government intervention to those who champion a strong, even paternalistic role for regulators.

In the last few decades, advances in behavioral psychology have complicated matters by identifying a third issue for debate. Specifically, theorists exploring the cognitive shortcuts and cultural predispositions that underlie public perceptions of risk have observed that policymakers must decide whether to respond to public fears (the “populist” view) or, at the opposite extreme, to regulate only those hazards that have a significant actual likelihood of causing serious – or at least expensive – harm to public health or welfare (the “technocratic” view).

This paper explores a phenomenon relevant to choosing a position in this last debate: what happens when the at-risk public responds differently to different layers of a multilayered risk. It is worth noting, however, that having populist or technocratic leanings does not determine one’s views on the scientific, economic and political issues that complicate risk regulation. A technocrat who firmly believes that government should respond only to “real” risks must still decide which type and level of response are scientifically and economically justified, and which are politically so. Thus, even if we could “mak[e] public opinion conform to the best available scientific information on risk,” numerous hard questions would remain.

B. Why Lay and Expert Opinions Differ

1. Overview

“Study after study shows that the public’s evaluation of risk problems differs radically from any consensus of experts in the field.”

---

33 E.g., LAWS OF FEAR, supra note 7, at 15-18 (summarizing the history of the principle and discussing its “widespread international support”)

34 E.g., W. Kip Viscusi, Constructive Cigarette Regulation, 47 DUKE L. J. 1095, 1101-02 (1998) (“The mere existence of a large risk, however, is not a legitimate rationale for government regulation . . . . In a world of rational choice, with full information, there would be no rationale . . . for interfering with [individual] decisions.”).


36 LAWS OF FEAR, supra note 7, at 126.

37 Fear of Democracy, supra note 1, at 1072.

38 Breuer, BREAKING THE VICIOUS CIRCLE, supra note 27, at 33. See also World Health Organization, The world health report 2002 - Reducing Risks, Promoting Healthy Life ch. 3 (2006), at http://www.who.int/whr/2002/chapter3/en/print.html (“By the early 1990s, particularly in North America and Europe, it became apparent that … risk had different meanings to different groups of people and that all risks had to be understood within the larger social, cultural and economic context.
The push to explain these findings began over three decades ago, when psychologists studying gambling preferences began to apply their findings to “human response to natural hazards.”39 In the intervening years, numerous studies have confirmed that individuals’ assessments of risk are colored by certain perceptual and analytic biases and shortcuts. For example, many people have an instinctive or affective reaction to risks that leads them to underestimate the risks of beneficial activities (activities with which they have positive associations) and to underestimate the benefits of risky activities.40 This mental rule-of-thumb, known as the “affect heuristic,”41 may help to explain why “feelings of dread [are] the major determiner of public perception and acceptance of risk for a wide range of hazards”: A particularly “dread” risk (that is, an uncontrollable risk, imposed involuntarily, with lethal consequences that are unfairly distributed across society) inspires strongly negative feelings that, in turn, lead individuals to assess the size of the risk as high.42

In a related phenomenon, many people overestimate the risks of activities of which they disapprove (“normative bias”43). Thus, those who vehemently oppose abortion may be more likely to believe the procedure poses dangers for pregnant women, while those who support choice may discount any such evidence as the product of junk science.44

Another important mental shortcut, the “availability heuristic,”45 has less to do with the characteristics of a risk than the recency with which

---

39 PERCEPTION OF RISK, supra note 3, at xxi.


41 Slovic, supra note 40, at 180.

42 Paul Slovic, What’s Fear Got to Do with It? It’s Affect We Need to Worry About, 69 MO. L. REV. 971, 976 (2004). See also, e.g., Finucane, et al., supra note 3, at 415-16; Sunstein, Book Review, supra note 3, at 1137. The affect heuristic helps to explain why “food additives, for example, tend to be seen as very high in risk and relatively low in benefit, whereas ... antibiotics and x-rays tend to be seen as high in benefit and relatively low in risk.” Slovic, supra note 40, at 180.

43 Misfearing, supra note 6, at 1119.

44 Id.

45 LAWS OF FEAR, supra note 7, at 36-39.
and manner in which it has been reported in the news. Specifically, “people often tend to assess probabilities based on whether a relevant incidence comes easily to mind.”\textsuperscript{46} If that incidence was catastrophic, the effect is even more pronounced.\textsuperscript{47} The 2006 e-coli scare\textsuperscript{48} provides a good example: In its immediate aftermath, people were more likely to worry about eating fresh vegetables from the store than about the risk of driving to the store in the first place.

Reinforcing the availability heuristic is an interesting attribute of social interactions: As people pass on stories about disasters, they often transmit not only objective information about the event but their own subjective fear. As a result, fears of “available” risks often prove contagious (the “cascade effect”\textsuperscript{49}). Additionally, groups of like-minded people tend to sharpen and reinforce each other’s views about such risks, leading to “group polarization.”\textsuperscript{50} Finally, the cascade effect and group polarization have a predictable effect in the workplace, where employees’ views about risk often come to resemble those of their employer institutions (“affiliation bias”\textsuperscript{51}).

2. The Bounded Rationality Model

Some theorists find these and similar biases and heuristics sufficient to explain most of what is observed about the selectivity – and occasional irrationality – of public fears. Professor Cass Sunstein, for example, identifies five culturally neutral factors that he deems “especially pertinent” to understanding differences in risk perception “across cultures and even across nations”: (1) the availability heuristic\textsuperscript{52}; (2) so-


\textsuperscript{47} See, e.g., Paula E. Berg, \textit{When the Hazard is Human: Irrationality, Inequity, and Unintended Consequences in Federal Regulation of Contagion}, 75 WASH. U. L.Q. 1367, 1403-04 (1997) (“Studies of risk perception demonstrate that the media’s tendency to focus on sensational, unusual, and catastrophic risks leads the public to overestimate the occurrence of these hazards.”).

\textsuperscript{48} See, e.g., Marian Burros, \textit{E. Coli Fears Inspire a Call for Oversight}, N.Y. TIMES B1, Dec. 9, 2006.

\textsuperscript{49} \textit{LAWS OF FEAR}, supra note 7, at 94-98.

\textsuperscript{50} \textit{Id.} at 98-102.

\textsuperscript{51} Nancy Kraus, Torbjorn Malmfors and Paul Slovic, \textit{Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks} 285, 311-313, in \textit{PERCEPTION OF RISK}, supra note 3. Kraus and her co-authors observe, for example, that “[t]oxicologists working for industry see chemicals as more benign than do their counterparts in academia and government.” \textit{Id.} This observation does not, of course, answer the causation question. Contrary to the assumption in the text, it may be that individuals who are predisposed to fear chemicals choose to work for academic or governmental employers, and those who dismiss such fears find the chemical industry a more welcoming work environment. Once such affiliations are created, however, one would expect the cascade effect and group polarization to solidify them.

\textsuperscript{52} See supra at 12.
called “probability neglect,” which refers to the human tendency to worry about worst-case scenarios, no matter how improbable; (3) loss aversion, which leads people to disfavor a potential loss more than they favor an equal and opposite potential gain;53 (4) widespread belief in the benevolence of nature; and (5) “system neglect,” or the tendency to focus on the effects of a risk to the exclusion of other important regulatory considerations, like the direct costs of government intervention and the potential risk-tradeoffs that might result from such intervention.54 According to Sunstein, observed correlations between people’s cultural framework and their perceptions of risk result from these and other bounds on rationality (notably the cascade effect and normative bias) that lead individuals of similar cultural backgrounds to reach similar conclusions about risks.55

Explaining this conception further, Sunstein divides the universe of risks into two categories: those that raise few political red flags (the risk of falling asleep at the wheel, say, or suffering a heart attack during exercise) and so-called “hot risks,” which are associated with issues that “trigger cultural conflicts” (for example, risks associated with abortion and gun ownership).56 To evaluate the former type of risk, he claims, individuals coolly assess the evidence, within the bounds of culturally-independent analytic shortcuts. For hot risks, on the other hand, heuristics and biases like the cascade effect, group polarization, and normative bias57 tend to bolster existing social or political divisions, leading people to favor the views held by others in their self-identified cohort. According to this model, then, any cultural schisms in risk perceptions are the product rather than the cause of perceptual shortcuts and biases.

Assuming for the moment that this bounded rationality model explains much of what is observed about human risk perception, how might regulators seek to alter public perceptions (or allay misperceptions) to foster public support for a desired regulatory program?58 There is no single answer to this question, but various risk perception theorists and behavioral psychologists have suggested partial

53 For example, people charge more to relinquish a good they already have than they are willing to pay to acquire the same good in the first place. LAWS OF FEAR, supra note 7, at 41-43.
54 Id. at 35.
55 Misfearing, supra note 6, at 1118.
56 Id. at 1115.
57 See supra at 12.
58 For the moment, this analysis begs normative questions about the wisdom and morality of such a deliberate “reeducation” campaign. The conclusion of the paper, however, begins to answer to the former question.
answers. Professor Paul Slovic, for example, emphasizes that it is very important that the public trust the individual who provides them with the risk information. In turn, “[t]o be credible and trustworthy, [the] communicator must know enough to acknowledge valid criticisms and to discern whether the available risk estimates are valid enough to help the public gain perspective on the dangers they face and the decisions that must be made.”

The accessibility of the presentation is also important. For example, people tend to understand comparisons better than “absolute numbers or probabilities, especially when” the latter are small. Thus, to educate someone about the risk of death from riding a motorcycle, it is less useful to present the absolute motorcycle-fatality rate (2000 per year per 100,000 persons at risk) than to compare that rate to the risk of smoking (300/100,000 per year), the risk of all motor vehicle accidents (24/100,000 per year) and the risk of being struck by lightning (0.05/100,000 per year).

Another accessibility consideration stems from the recognition in the psychology literature that people tend to understand frequencies better than probabilities. For example, consider the following ways of presenting information about the reliability of a medical test:

- “[A] test to detect a disease whose prevalence is [one in a thousand] has a false positive rate of [five percent],” or
- “One out of a thousand Americans has a disease; fifty out of a thousand healthy people test positive.”

In both examples, the probability that a person who tests positive has the disease is approximately 1 in 50. But people understand that fact much more intuitively when presented with the second statement.

Importantly, though, improving trust and accessibility only address strict inaccuracies in public perceptions. As noted above, some of the difference between lay and expert risk assessments stems not from analytic mistakes but from perceptual biases that lead people to fear certain kinds of risk more than other risks of comparable size, depending on affective factors like “uncertainty, controllability, catastrophic potential, equity and threat to future generations.” Thus, an education effort that simply compares, say, “the annual risk from living near a

---

59 Paul Slovic, Informing and Educating the Public about Risk 182, 183, in PERCEPTION OF RISK, supra note 3; Slovic, supra note 27, at 392.

60 Slovic, Informing and Educating, supra, at 187.

61 Id.


63 Paul Slovic, Informing and Educating the Public about Risk 190, in PERCEPTION OF RISK, supra note 3, at 190.
nuclear power plant” to that from driving a car may “appear ludicrous because [it] fails to give adequate consideration to … important differences in the nature” of these hazards.64 Instead of resorting to such simple comparisons, then, risk educators must recognize that “[l]aypeople’s basic conceptualization of risk” reflects “concerns that are typically omitted from expert risk assessments.”65 In short, changing minds requires a “two-way process” in which “[e]ach side, expert and public, … respect[s] the insights and intelligence of the other.”66

Along these lines, producer and journalism professor Jon Palfreman argues that “journalists should expand their narrative horizons: to include not just the facts about the risk in question but also how people feel about the risk and why. In essence, they should report two dimensions of the risk story – the physical narrative … and the psychological subtext.”67 In the specific context of climate change, for example, Palfreman suggests that journalists might have more success “getting people to focus on global climate change” if they emphasized its implications for future generations – “the ‘legacy’ concept” that underlies much public concern about nuclear power.68 “If we all have available an image of our grandchildren struggling with irreversible climate change,” he claims, “the problem seems less abstract and more pressing.”69

This summary is incomplete but provides some sense of the necessary ingredients of an education strategy that aims to overcome (or, more accurately, account for) bounds on strictly rational risk assessment: trust in the educator, accessible presentation of the facts, and framing that is sensitive to the specific risk characteristics that underlie much public fear. In the discussion below, references to a “bounded-rationality campaign” to convince the public to accept nuclear power as a solution to climate change refer to a hypothetical campaign that perfectly incorporates these and other important insights about the biases and heuristics that influence lay perceptions.

3. The Cultural Cognition Model

The cultural cognition model offers an alternative explanation for some of the observed shortcomings in public risk perception, and it may

64 Id. at 190-91.
65 Id. at 191.
66 Id.
68 Id. at 191-192.
69 Id. at 192.
therefore call for an alternative (hypothetical) educational approach. Without rejecting bounded rationality, the cultural cognition model argues that “worldviews permeate all of the mechanisms through which individuals apprehend risk” – including the biases and heuristics discussed above.\(^{70}\) Authors in this area identify two possible worldview axes and assert that individuals “conform their beliefs about risk” to their coordinates in this two-dimensional space – that is, effectively, “to their visions of an ideal society.”\(^{71}\)

As illustrated below, the two axes are “grid” (hierarchical to egalitarian) and “group” (individualist to solidarist/communitarian).\(^{72}\)

![Diagram of two-dimensional worldview axes](image)

According to this model, strict hierarchists distrust reports of environmental risk, because they are inclined to “believe in a high level of stratified prescriptions,”\(^{73}\) and they “perceive warnings of imminent environmental catastrophe as threatening the competence of social and governmental elites.”\(^{74}\) Strict individualists, too, “predictably dismiss claims of environmental risk as specious, in line with their commitment to the autonomy of markets and other private orderings.”\(^{75}\) Strict egalitarians and solidarists, on the other hand, are predisposed to favor regulation of environmental risks, because such regulation holds in check “commercial activities,” which produce social inequalities (anathema to

\(^{70}\) *Fear of Democracy*, supra note 1, at 1072.

\(^{71}\) *Id.*

\(^{72}\) *Cultural Cognition*, supra note 29, at 153-54.


\(^{74}\) *Fear of Democracy*, supra note 1, at 1073-74.

\(^{75}\) *Id.*
egalitarians) and “legitimize unconstrained self interest” (ditto to solidarists).  

Can these cultural predispositions be overcome?  Proponents of the cultural cognition model believe so:  

Nothing in our account implies either that there is no truth of the matter on disputed empirical policy issues or that the public cannot be made receptive to that truth. Like at least some other cognitive biases, cultural cognition can be counteracted…. [F]actual disputes over gun control, the death penalty, environmental regulation and like issues derive from individuals’ resistance to accepting information that threatens their cultural commitments. It follows that individuals are likely to resist factual information less if it can be presented in forms that affirm rather than denigrate their values.  

Professors Dan Kahan and Donald Braman have discussed the practical application of this “affirmation” strategy. They contend that affirming cultural identities renders individuals “more open” – both attitudinally and cognitively – “to reconsidering their beliefs on culturally contested issues.” Thus, policymakers seeking to overcome cultural biases on a particular issue should “design[] policies that are sufficiently rich in their social meanings to affirm the values of persons of diverse cultural worldviews simultaneously.”  

Two examples of this approach are directly relevant here. The first “concerns the emergence of political consensus in favor of tradeable emissions permits as a means of regulating air pollution in the late 1980s and early 1990s.” According to Kahan and Braman, policymakers achieved this result by relying on “a market mechanism for controlling pollution,” thereby (1) “vindicat[ing] individualists’ belief that private orderings conduce to societal well-being”; (2) “affirm[ing]” hierarchists with “a policy that promised to empower … powerful commercial firms”; and (3) “recognizing” egalitarians’ and solidarists’ “view[s] of the dangers of unconstrained commerce and industry.” Overall, this approach made it easier for individualists and hierarchists “to accept that air pollution was a problem to begin with,” and for egalitarians and

76 Cultural Cognition, supra note 29, at 154.  
77 Id. at 168.  
78 Id.  
79 Id.  
80 Id. at 169.  
81 Id.
solidarists “to accept evidence that uniform, centrally enforced air quality standards don’t work.”

The second relevant example concerns the nuclear power debate that is the subject of this paper. The same authors suggest, briefly, that their affirmation approach might work to convince the public to accept nuclear power as a solution to climate change:

The self-affirmation effect suggests [that a proposal to renew investment in nuclear power as a way to reduce greenhouse gas emissions] might actually change minds, both about the dangers of global climate change and about the risks of nuclear energy. Individualists and hierarchists both support nuclear power, which is emblematic of the very cultural values that are threatened by society’s recognition of the global warming threat. Shown a solution that affirms their identities, individualists and hierarchists … can be expected to display less resistance—not just politically, but cognitively—to the proposition that global warming is a problem after all. Likewise, when egalitarians and solidarists are exposed to the same information, they are likely to perceive nuclear power to be less dangerous: The affirmation of their identity associated with the recognition of the global warming threat lowers the cultural status cost of accepting information about nuclear safety that they have long resisted. According to this view, then, the self-affirmation effect offers an approach for policymakers who seek to shift public opinion about nuclear power. References in the below discussion to a “cultural cognition campaign” refer to a hypothetical perfect-realization of this approach.

III. Risk Perception and the Nuclear Power Debate

Having outlined the two salient risk-perception models, and each model’s suggested tactics for shaping public perceptions, this paper next considers how we might expect these approaches to perform in practice. That is, in the context of a particular policy debate, would a public education strategy based on either the bounded rationality or cultural cognition model shift public opinion in the desired direction? And if so, is such a shift likely to lead to an objective improvement in public policy? Importantly, the latter two questions are distinct. Moreover, as the following discussion of the nuclear power debate illustrates, an

82 Id.

83 Id.
affirmative answer to the first does not ensure an equally favorable answer to the second.

This section first introduces the debate – what are the risks of climate change and nuclear power; what would it mean for nuclear power to play a significant role in a climate change strategy; and what regulatory changes would be required to facilitate the necessary growth of the nuclear sector and to address any attendant risks.

Turning to the public-opinion piece of this puzzle, the section then hypothesizes a bounded-rationality and a cultural-cognition risk-education strategy, each aimed at convincing people to support nuclear power as an approach to climate change, and asks (1) whether either strategy would be successful, and (2) if so, what that success would “look like” in practice. The results of this theoretical exercise are worrying, not just for nuclear enthusiasts, but for anyone who hopes to use insights from behavioral psychology to move public opinion in a useful direction.

A. The Nuclear Power Example

The increasing scientific certainty that global warming poses serious risks to present and future generations has revived interest in nuclear power as a “carbon-free” power source that could help satisfy the world’s growing energy needs without contributing significantly to the greenhouse effect.\(^84\) Even some environmentalists, formerly opposed to nuclear technology, have revised their views, arguing that we should explore nuclear energy as a supplement to conservation and to renewable energy technologies like wind and solar power.\(^85\) Other longtime opponents, incensed by this softening of position, remind the world in strident terms of the many unsolved problems nuclear power poses – notably its upfront costs, attendant safety and proliferation risks, and waste transport, storage, and disposal issues.\(^86\)

\(^{84}\) See supra note 19 and associated text.

\(^{85}\) See, e.g., Going Nuclear: A Green Makes the Case, THE WASHINGTON POST B01, Apr. 16, 2006; Peter N. Spotts, Simpler – and Safer, THE CHRISTIAN SCI MONITOR 13, June 2, 2005 (“[F]aced with global warming, some groups, such as the Pew Center on Global Climate Change and Environmental Defense, appear willing to give nuclear energy a reluctant second look.”); Felicity Barringer, Old Foes Soften to New Reactors, N.Y. TIMES A1, May 15, 2005 (citing articles and statements by Stewart Brand, founder of the Whole Earth Catalog, Fred Krupp, Executive Director of Environmental Defense; Jonathan Lash, President of the World Resources Institute, and James Gustave Speth, Dean of the Yale School of Forestry and Environmental Studies); James Lovelock, Our Nuclear Lifeline: Go Nuclear? A Leading Environmentalist Says the Greens Are Plain Wrong to Oppose It, READERS DIGEST 2, Mar. 2005; Amanda Griscom Little, Green vs. Green: The Environmental movement, Once Stauncly Antinuclear, Is Facing Resistance from Within, WIRED, Feb. 2005, at http://www.wired.com/wired/archive/13.02/nuclear.html?pg=5.

\(^{86}\) See, e.g., Caldicott, supra note 21; Greenpeace, Nuclear Power, at http://www.greenpeace.org.uk/en/nuclear/nuclear_power.cfm (“Nuclear power is quite simply dirty, dangerous, old-fashioned, unnecessary and uneconomic.”); U.S. PIRG, Nuclear Power Not Needed
Given the stridency of this debate, one important and largely unaddressed question is whether public opinion stands as an independent barrier to any climate change strategy based predominantly or even significantly on safe growth of the nuclear power sector. Put differently, suppose policymakers uniformly believed that nuclear power posed lesser risks than climate change, and that we should shift a significant portion of U.S. energy production from traditional fuels to nuclear as part of our effort to reduce greenhouse gas emissions. Could the public be persuaded to support this approach? And equally importantly, what might be the consequences of an attempt to shift attitudes in this wholesale way?

This paper makes no effort to plumb the depths of current thinking on either climate change or nuclear power. It is sufficient for this discussion to make a few brief points: (1) the fact of human-induced climate change is increasingly certain, and current predictions suggest that the effects of the warming—though difficult to predict and almost impossible to monetize—will be massive and costly; (2) focusing strictly on greenhouse gas emissions, nuclear power is “cleaner” than traditional power sources, but converting much of the world’s energy supply to nuclear is neither a complete solution to climate change nor a necessary piece of the solution; (3) to play a nonnegligible role in our climate change strategy, the nuclear power sector will have to grow drastically; (4) stimulating the required growth of the nuclear power sector will require regulatory action; and finally, (5) there are significant ancillary risks of that growth, and addressing those risks, too, will require substantial regulatory action.

1. Scientific certainty about the effects of climate change

There is “growing consensus among climate scientists worldwide about the seriousness of potential risks posed by global warming.” 87 The

---

87 Elke U. Weber, Experience-Based and Description-Based Perceptions of Long-Term Risk: Why Global Warming Does Not Scare Us (Yet), 77 Climatic Change 103 (2006). See also IPCC, Climate Change 2007: The Physical Science Basis 5, 8, 10 (2007), at http://www.ipcc.ch/SPM2eb07.pdf (hereinafter "IPCC Science 2007") ("Warming of the climate system is unequivocal. Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed, including widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones."); Sir Nicholas Stern, The Economics of Climate Change: Summary of Conclusions i (2006), at http://www.hm-treasury.gov.uk/media/8ACF7/Executive_Summary.pdf ("The scientific evidence is now
most oft-discussed such risk is the likely rise in sea surface levels,\textsuperscript{88} which will confront low-lying communities with a stark choice: invest in elaborate levee systems or risk inundation. There are many other dangers, however, including increased storm intensity; increased rainfall (in some areas); pervasive drought (in others); more frequent wildfires; rapid loss of biodiversity, particularly in polar climes and in sensitive ecosystems like coral reefs; expanded seasons and ranges for some noxious species, including allergenic grasses and tropical disease agents; and even significant changes in ocean circulation and, as a result, coastal climates.\textsuperscript{89} The costs to humans of these various changes in our natural environment are many and varied, ranging from minor weather changes to disruption of our food and water supplies, flooding and other natural disasters, and deadlier and more frequent epidemics.\textsuperscript{90} Moreover, these effects will hit hardest in the poorest countries, posing “a grave threat to the developing world and a major obstacle to continued poverty reduction.”\textsuperscript{91}

Predicting which effects will happen where, and when, has proven virtually impossible, but the best minds in the business have concluded that warming is all but certain to impose enormous worldwide costs unless we take action to reduce global greenhouse gas emissions.\textsuperscript{92} For example, a recent U.K. economist’s report concludes that “if we don’t act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP” and up to “20% … or more … each year, now and forever.”\textsuperscript{93} The same author estimates that the annual costs of stabilizing greenhouse gas concentrations at a safe level would overwhelm: climate change presents very serious global risks, and it demands an urgent global response.”\textsuperscript{94}

\textsuperscript{88} Indeed, some sea level rise has already been observed. IPCC Science 2007, \textit{supra}, at 5, 7. Interestingly, this sea surface rise results not just from an increase in ocean volume as polar ice caps melt, but also from a decrease in the density of ocean water as average water temperatures rise. See, e.g., NASA Jet Propulsion Laboratory, \textit{What’s up with Sea Level} (June 2006) at http://sealevel.jpl.nasa.gov/newsroom/features/200606-1.html (“Global sea level can rise for one of two reasons,” says JPL oceanographer Dr. Josh Willis. ’One is when water gets hotter, it expands. The other is when water is added to the ocean, which changes its mass. That happens, for example, when glaciers melt.’

\textsuperscript{89} IPCC Science 2007, \textit{supra} note 87, at 8-9; see also Smith, \textit{supra} note 20, at 15-31.

\textsuperscript{90} See generally IPCC, \textit{Climate Change 2007: Impacts, Adaptation and Vulnerability} (forthcoming April 6, 2007) (hereinafter “IPCC Impacts 2007”); Stern, \textit{The Economics of Climate Change}, \textit{supra} note 87, at v (summarizing likely effects on the human environment); Smith, \textit{supra} note 20, at § 1.2.

\textsuperscript{91} Stern, \textit{supra} note 87, at vii; see also IPCC Impacts 2007, \textit{supra}.

\textsuperscript{92} Stern, \textit{supra} note 87, at vii.

\textsuperscript{93} \textit{Id.} at i.
be “significant but manageable” – on the order of 1% of GDP by 2050.94 These dollar figures need not be strictly accurate for one to conclude that society should carefully evaluate the cost effectiveness and feasibility of all serious suggestions for mitigating greenhouse gas emissions.

2. Nuclear power as part of the solution

One widely-touted such suggestion is to increase reliance on nuclear power. With respect to greenhouse gas emissions, nuclear power is cleaner than traditional fuel sources and competitive with renewable technologies.95 Moreover, at least the former comparison remains true even on a cradle-to-grave accounting – that is, even if one takes full account of the greenhouse gases emitted in mining, processing, transporting, storing, and disposing of radioactive fuels.96 Thus, shifting some percentage of U.S. energy production from traditional fuels to nuclear power would provide climate change benefits.97

That said, it would not be feasible to convert 100% of the U.S. power sector to nuclear energy, and even if complete conversion were possible, the United States would still contribute significantly to global greenhouse gas emissions. For one thing, nuclear power “is generally seen as a better fuel for base load … conditions than for meeting cyclical peak loads.”98 Further, as noted above, mining, processing, transporting, storing, and disposing of radioactive fuels produce significant quantities of greenhouse gases.99 Finally, other sectors of the U.S. economy are significant sources of greenhouse gases. The transportation sector, for example, currently accounts for about ¼ of U.S. greenhouse gas emissions.100

An equally important and related point is that wholesale conversion to nuclear power is not necessary to global greenhouse gas mitigation

94 Id. at xii.
95 See supra note 20.
96 Id.
97 This claim is, of course, tempered by other countries’ growing contribution to the problem, see IAE, supra note 19 (“Within two years, [China will] produce more greenhouse gases from human sources than the United States.”), and by the fact that existing atmospheric greenhouse gas concentrations may make some warming inevitable, NSF, Climate Change Inevitable in 21st Century, Press Release 05-043 (Mar. 17, 2005), at http://www.nsf.gov/news/news_summ.jsp?cntn_id=103108.
99 See supra note 20 and associated text.
efforts. Other approaches that could – in some combination – produce the necessary emissions reductions include reduced vehicle use; more efficient appliances, buildings, and vehicles (e.g. hybrids and fuel-cell vehicles); greater use of wind and other renewable energy sources; better agricultural practices; use of clean coal technologies; and further development and implementation of carbon capture and storage technologies. Comparing the costs, benefits, and feasibility of nuclear power and these various other greenhouse gas reduction alternatives is well beyond the scope of this paper; the important point for this discussion is that the “nuclear option” is neither a complete solution to climate change nor a necessary piece of the complete solution.

At the end of the day, then, we can dispense quickly with the assertion that we must resort to nuclear power if we are to avert climate catastrophe. That scare tactic at once over-promises (because nuclear power is not a complete solution) and overreaches (because nuclear power is not a necessary piece of the complete solution). Rather, society must focus on the real calculus of the nuclear option and make a measured choice whether significant investment in the sector is both practicable and worthwhile.

3. Scale of the necessary investment in nuclear power

One variable relevant to this choice is often overlooked in popular debates: the scale of the investment in nuclear energy that would be necessary to make a dent in greenhouse gas emissions. That is, if nuclear power is to play a nonnegligible role in the global climate change solution, must energy companies build a few additional plants somewhere in the country every twenty years? Five new plants each decade? Or ten new plants each year? It turns out, pivotally, that

---

101 Stephen Pacala and Robert Socolow, Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, 305 Science 968, 969-70 (2004) (describing fifteen so-called “wedges,” or potential carbon reduction approaches, any seven on which would be sufficient to stabilize carbon emissions at their current levels for the next 50 years, thereby keeping open the possibility that we could, eventually, develop the additional technologies necessary to reduce emissions still further and stabilize atmospheric carbon concentrations); see also Roger A. Pielke, Jr., What just ain’t so: It is all too easy to underestimate the challenges posed by climate change, 443 Nature 753, 753 (2006) (reviewing William Sweet, KICKING THE CARBON HABIT: GLOBAL WARMING AND THE CASE FOR RENEWABLE AND NUCLEAR ENERGY (2006), and noting that "Pacala and Socow recognize that what they have proposed is only a start[. E]ven after the successful implementation of seven of their wedges by 2054, ‘fossil fuel emissions must decline’ by about an additional two thirds over the subsequent 50 years").

102 This paper focuses on the United States’ nuclear industry, but many of the arguments are also applicable to other countries. Moreover, a worldwide shift to nuclear power is unlikely without significant U.S. involvement. See Massachusetts Institute of Technology, The Future of Nuclear Power: An Interdisciplinary MIT Study 3 (2003), at http://web.mit.edu/nuclearpower (hereinafter “MIT Study”).
nuclear power cannot significantly reduce the risk of climate change unless we commit to a vast global investment in the technology.\textsuperscript{103}

To estimate the scale of the necessary investment over the next half-century, one must first answer several predicate questions. For example, how is per capita power demand likely to grow in developed, developing, and least-developed countries? How is each country’s population likely to grow in the same period? And what are the mid-century alternatives to nuclear power likely to be? In other words, in 2050, are we likely still to rely on coal, oil, and natural gas to supply power needs that are not met by nuclear, or will we have developed other affordable alternatives?\textsuperscript{104}

A 2003 interdisciplinary MIT study, The Future of Nuclear Power, makes a credible effort to address these questions.\textsuperscript{105} As a baseline, the authors use 2002 figures for global electricity consumption, observing that in that year, nuclear power accounted for 20% of U.S. electricity use and 17% of global use.\textsuperscript{106} The Study then models mid-century electricity demand, using U.S. and U.N. predictions of annual population growth and annual per capita growth in electricity demand.\textsuperscript{107} The resulting estimates of mid-century electricity use are staggering, ranging up to a figure 180% higher than 2000 levels.\textsuperscript{108} Moreover, the Study’s

\textsuperscript{103} Id. at 25 (“From a public policy perspective, the scenarios that merit analysis are either a large-scale deployment or a phase-out of nuclear power over the next half-century.”); id. at 28 (“[T]he nuclear power option makes sense only if possible deployment is quite large, since no small deployment can make a significant contribution to dealing with the greenhouse gas problem…. Indeed it is misleading to focus on small increases in nuclear capacity justified by significant CO\textsubscript{2} reduction.”); Arjun Makhijani, Atomic Myths, Radioactive Realities: Why Nuclear Power Is a Poor Way to Meet Energy Needs, 24 J. LAND RESOURCES \& ENVTL. L. 61, 66 (2004) (“If the world continues to use oil for transportation … [thousands] of nuclear power plants will have to be built in the next four decades to mitigate carbon dioxide emissions.”).

\textsuperscript{104} This question is important because without some estimate of the mid-century level of greenhouse gas emissions in the absence of a significant nuclear industry, one cannot predict either (1) the level of emissions reductions necessary to abate global warming or (2) the extent to which a given investment in nuclear power would produce such reductions.

\textsuperscript{105} For skeptics, it is worth noting here that the MIT study cautiously supports expansion of the nuclear sector. MIT Study, supra note 102, at 1.

\textsuperscript{106} Id.

\textsuperscript{107} Id. at 109-115 (Appendix A). The authors subdivided developing countries into three categories – more advanced (projected to achieve a benchmark electricity demand of 4000 kWh per person per year by 2050); less advanced (projected to reach “acceptable” levels of energy demand in the range of 1500-4000 kWh per person per year by 2050); and least developed (unlikely to reach even 1000 kWh per person per year by 2050). Id.

\textsuperscript{108} Id. at 115. This increase represents an annual growth rate of 2.1%. By comparison, global population is only projected to grow by about 50% in the same 50 year period. Id. at 115 (Table A-2.1e). As may be obvious, growth in energy demand is projected to outstrip population growth principally because developing countries’ energy demand is likely to increase rapidly as their citizens’ standards of living improve.
predictions for 2050 levels are relatively conservative, falling between the U.S. Energy Information Agency’s “low growth” and “business as usual” scenarios, and well below its “high growth” figures.109

Next, the MIT authors consider various possible growth scenarios for the nuclear power sector, from growth at a rate just sufficient to maintain nuclear power at its current share of world electricity capacity (17%), to growth sufficient to reach a market share of 25% by 2050.110 These scenarios are not predictions; rather, they estimate the extent of deployment required for nuclear power to maintain its current market share – a baseline that the authors use to represent the minimum industry growth necessary for nuclear to play a significant role in greenhouse gas reduction efforts.111

These machinations lead the authors to a mid-century estimate for the nuclear industry of 1000 to 1500 Gigawatts electric capacity (“GWe”).112 Several things about this range are immediately noteworthy. First, it reflects an increase of between 170 and 300 percent above current global nuclear capacity.113 Second, reaching the high end of the range would require construction of more than 1100 new, large nuclear facilities somewhere in the world by 2050 – almost 25 per year, or about one every two weeks.115 Of these, the MIT authors speculate that about a third would be in the United States, for an average

---

109 Id. at 110. The EIA’s scenarios end in 2020, but the curve on which the MIT Study’s maximum 2050 estimate is based falls between the EIA’s “reference” and “low growth” scenarios in the years 2000-2020. See id., Figure A-2.2. Not surprisingly, much of the predicted expansion in electricity demand is expected to occur in the developing world. Id. at 22.

110 Id. at 25. The authors do not actually expect the nuclear power sector to follow any of these growth scenarios; they merely analyze the scenarios to determine what changes would facilitate the necessary sector growth. That is, they assume a worldwide decision to keep nuclear power at or above its current share of global power production, and analyze what political and technological changes would be necessary to make that happen.

111 One can, of course, quibble about the MIT Study’s definition of “significant,” but with energy demand growing at the rates predicted by the EIA and others, see supra note 109 and accompanying text, it seems reasonable to assert that if nuclear power is to have any real role to play in a climate change strategy, it must at least maintain its current market share of just under 20%.

112 MIT Study, supra note 102, at 25 (Table 3.1).


114 Large nuclear plants have a capacity of about 1 GWe. If countries chose instead to build smaller facilities, the rate of construction would have to be correspondingly higher.

115 MIT Study, supra note 102, at 25-28. Current capacity is equivalent to 366 1 GWe plants. Achieving a global capacity of 1500 GWe would therefore require construction of at least 1134 new large (1 GWe) facilities. This is an underestimate, however, because some existing plants will undoubtedly need to be replaced by mid-century.
construction rate of 7-10 large facilities per year. By comparison, in the heyday of nuclear power, “worldwide construction” of light water reactors “totaled about 400 plants over 25 years, for an average of 16 plants completed per year.”

The MIT study is not the only one to conclude that we must build thousands of new nuclear plants in the next decades if we hope to make nuclear power a real part of our climate change solution. The President of the Institute for Energy and Environmental Research, for example, estimates that to “make a significant dent in [mid-century] CO₂ emissions,” we would need to increase global nuclear capacity to about 2,000 GWe over the next four decades, which in turn would necessitate a plant construction rate of “about one per week.” And an important recent climate change article in Science Magazine, which identifies policy alternatives to stabilize greenhouse gas emissions by mid-century, indicates that even if nuclear power is just one of 7 strategies on which we place equal reliance, we must increase capacity by about 700 GWe by 2050 (or almost 20 new large plants each year).

Finally, to drive home the point that only a truly massive investment in nuclear power will permit the industry to play a nonnegligible role in mitigating greenhouse gas emissions, it is worth emphasizing that the hypothesized deployments discussed above would fall far short of solving the climate problem. Indeed, constructing the new plants that would be necessary to reach the low end of the MIT Study’s hypothetical

---

116 Id. at 26 (Table 3.2). Given that no plants are currently under construction in the United States, and many existing plants are reaching the end of their lifecycles, however, building rates toward the end of this half-century period would probably have to be considerably faster than 10-large-plants per year.

117 Id. at 49 (emphasis added).

118 Makhijani reasons as follows: “If the world continues to use oil for transportation … a very large number of nuclear power plants [would] have to be built in the next four decades to mitigate carbon dioxide emissions…. In order to make a significant dent in CO₂ emissions, at least one-third, and perhaps one-half or more of the global growth in electricity demand must be supplied by nuclear power. In any scenario involving two percent or greater global electricity growth, the use of nuclear power will mean the construction of thousands of nuclear power plants in the next four decades. Consider for instance, an electricity growth rate of two percent, which is far less than that occurring in China and India, but more or less typical of recent U.S. trends. To make a substantial contribution to reducing greenhouse gas emissions, we might hypothesize that (i) all present day nuclear power plants will be replaced by new ones, (ii) half the electricity growth will be provided by nuclear power, and (iii) half of the world’s coal-fired plants will be replaced by nuclear power plants. This would mean that about two thousand large (1,000 megawatts each) nuclear power plants would have to be built over the next four decades. That is a rate of about one per week.” Makhijani, Atomic Myths, supra note 103, at 66.

119 Pacala & Socolow, Stabilization Wedges, supra note 101, at 970 (Table 1). As noted in footnote 101, supra, these authors identify policies that could stabilize emissions by 2050. These policies fall far short of what would be required to stabilize atmospheric concentrations of greenhouse gases, as will eventually be necessary to avert climate change. Pielke, What just ain’t so, supra note 101, at 753.
range would avoid only about a quarter of the anticipated growth in anthropogenic carbon emissions between 2000 and 2050.120

4. Economic incentives to boost the nuclear sector

What would it take, then, to stimulate growth of the U.S. nuclear sector at a rate far higher than that in the heyday of the industry? At very least, regulators would have to address the dismal economics of nuclear power.

The first commercial nuclear power plant opened its doors in Shippingport, Pennsylvania, in 1957. In the next four decades, just over 100 reactors came online, at 65 sites in 31 states. Since 1978, however, no new plants have been ordered and more than 100 reactor contracts have been canceled. No units are currently being constructed, and the last reactor to come online (the Tennessee Valley Authority’s Watts Bar reactor in Tennessee) was ordered in 1970 and licensed in 1996. In the last decade, the industry has been essentially dormant. The same is true in many other countries: A $4 billion nuclear plant now facing costly construction setbacks in Finland is the first plant to be built in Europe in 15 years.121

Writers on all sides of the nuclear debate agree that the principal reason for the industry’s present state is the high cost of nuclear power.122 While operating plants are generally competitive with coal- and natural gas-fired power plants, construction costs for new plants are prohibitively high.123 Indeed, assuming moderate gas prices, the levelized cost of electricity from a new nuclear plant is about 60 percent higher than from a new coal or gas plant.124 Although a national tax on carbon emissions would even this playing field somewhat, the tax would have to be near the upper end of the literature range ($100-200/ton

120 To make this calculation, the MIT authors assume that “[d]espite the efforts to promote renewable energy options, … a large fraction of the incremental and replacement investments in electric generating capacity needed to balance supply and demand over the next 50 years will, in the absence of a nuclear generation option, rely on fossil-fuels.” MIT Study, supra note 102, at 37. For purposes of this discussion, the important implication of this passage is that for the foreseeable future, it is appropriate to use fossil-fuel emission rates as a conservative baseline in calculating how additional nuclear capacity would affect greenhouse gas emissions. Painting an overly rosy picture of mid-century energy production (e.g., assuming that by 2050, 50% of U.S. electricity will be supplied by wind and solar power) would underestimate the necessary level of investment in nuclear.


123 See, e.g., CRS, Nuclear Energy Policy, supra, at CRS-2; NRDC, Commercial Nuclear Power, supra, at 6.

124 MIT Study, supra note 102, at 42 (Table 5.1).
carbon) before nuclear becomes fully cost-competitive. To “make early nuclear plants more competitive,” therefore, researchers at the University of Chicago suggest such federal policies as “loan guarantees, accelerated depreciation, investment tax credits, and production tax credits.”

The Energy Policy Act of 2005 makes some of these changes. For example, it creates a $125 million/year/GW tax credit for up to 6 GW of new nuclear capacity (about 6 large plants) for up to 8 years of operation – in other words, up to 6 plants could receive up to $1 billion each in tax credits. The Act also extends the Price Anderson Act’s liability indemnification provisions (and pool of funds) for another 20 years, to 2025. In addition, it addresses the historic problem of regulatory delays, authorizing the Department of Energy to reimburse utilities for up to $500 million in costs related to Nuclear Regulatory Commission (“NRC”) delays. Finally, the Act establishes a federal loan guarantee program, covering up to 80% of construction costs, to improve the odds for lenders, which have historically charged higher interest rates for nuclear plant construction loans.

As a result of these and other recent changes (including higher natural gas prices), some utilities have expressed renewed interest in nuclear power, announcing plans to apply for combined construction and operating permits for 11 new reactors. As yet, however, no utilities have committed to ending the almost 30-year hiatus in new plant construction, let alone to dedicating resources to nuclear power development at the level that would be necessary to build 7-10 new plants per year for the next 4 decades. If those numbers even approximate our goal, therefore, the Energy Policy Act’s billions of

---

125 Id. at 42.

126 See, e.g., Marshall Goldberg, Federal Energy Subsidies: Not All Technologies Are Created Equal (2000) (“[C]umulative federal government subsidies to [nuclear, wind, photovoltaic, and solar thermal electricity generating technologies] … [f]rom 1943 to 1999 … totaled almost $151 billion (in 1999 dollars),” of which the “nuclear industry received $145.4 billion, or over 96 percent”); CRS, Nuclear Energy Brief, supra note 133, at CRS-13 (indicating that in 2006, Congress appropriated almost $540 million to the Department of Energy (“DOE”) for civilian nuclear power research and development, and another half a billion dollars for civilian nuclear waste disposal). Note further that these figures do not include the vast sums in indirect subsidies from nuclear research and development activities undertaken in connection with national defense.


129 CRS, Nuclear Energy Policy, supra note 133, at CRS-2.

dollars of economic incentives fall far short of what would ultimately be necessary.

5. **Risks and possible regulatory reforms**

Growing the nuclear sector at the MIT Study’s hypothesized rate would pose significant risks. The Study authors discuss these concerns in three categories: safety, proliferation, and waste.

   a) **Reactor safety**

   The Three Mile Island accident in Pennsylvania and the Chernobyl disaster in the former Soviet Union highlight one of the most salient nuclear power risk – the chance of leakage from or meltdown of a reactor. Investing heavily in the nuclear sector would also raise other safety concerns, however, including the increased likelihood of either a natural disaster (e.g. an earthquake or flood) or a terrorist attack at a nuclear plant. Moreover, other than meltdown, none of these concerns is confined to energy-producing reactors; they extend to the various components of the nuclear fuel cycle, including fuel fabrication facilities, waste handling, storage, and disposal facilities, and, if a closed (i.e. recycling) fuel cycle is used, fuel reprocessing facilities.\(^{131}\)

   The important questions, then, are (1) the likelihoods of these various disasters, and (2) their projected costs, not just in people injured or killed, but in disruption of power supplies, destruction of capital assets, and – of particular relevance to this paper about public risk perception – erosion of “public confidence in nuclear generation.”\(^{132}\)

   The answer on likelihood is not a welcome one. Experts who have evaluated the issue with probabilistic risk assessment conclude that assuming current technology, the “best estimate of core damage frequency” is “about 1 in 10,000 reactor-years.”\(^{133}\) For the current U.S. fleet of about 100 reactors, this works out (of course) to a rate of about 1 accident per century. But a three-fold increase in nuclear capacity – what the MIT Study dubs a “global growth scenario” – would yield an “expected number of core damage accidents” of 4 by 2055.\(^{134}\) Harvard professor of earth and planetary sciences Daniel Schrag agrees with this dire prediction: “‘Think about a world with 10,000 nuclear reactors,’ says Schrag, who envisions a quintupling of capacity to address climate

---

131 MIT Study, *supra* note 102, at 47-51.

132 *Id.* at 48.

133 *Id.; see also* CRS, *Nuclear Energy Policy, supra* note 133, at CRS-7.

change. ‘We have only a few hundred today. What is the probability of a big accident? It’s going to happen.’”

That likelihood only goes up when one adds terrorist attack into the mix. In the United States, all licensed commercial plants are required to have a series of physical barriers and to “maintain a trained security force.”

But the Energy Policy Act of 2005 essentially admitted the inadequacy of existing security procedures, requiring the NRC (1) to revise its “design basis threat” (the most severe threat for which plants must be prepared) “based on an assessment of terrorist threats, the potential for multiple coordinated attacks, [and] possible suicide attacks,” (2) “to conduct force-on-force security exercises at nuclear power plants every three years,” and (3) to fingerprint all nuclear facility workers.

With respect to the costs of an accident, the news is more mixed. On the one hand, the U.S. nuclear industry’s single true accident – Three Mile Island – caused no deaths or injuries “to plant workers or members of the nearby community,” and “[a] study of 32,000 people living within 5 miles of the reactor when the accident occurred found no significant increase in cancer rates through 1998, although the authors note[d] that some potential health effects ‘[could] not be definitively excluded.’”

The Chernobyl accident was far more serious, killing more than 30 people within hours or days, necessitating the immediate evacuation of 116,000 people and the subsequent evacuation of an additional 230,000, and releasing “massive amounts of radioactivity into the environment.”

Even in Chernobyl, though, the most recent health figures are more (albeit not wholly) positive:

[T]he total number of people that could have died or could die in the future due to Chernobyl originated exposure over the lifetime of emergency workers and residents of most contaminated areas is estimated to be around 4,000. This total includes some 50 emergency workers who died of acute radiation syndrome (ARS)


137 Id.


in 1986 and other causes in later years; 9 children who died of thyroid cancer; and an estimated 3,940 people that could die from cancer contracted as a result of radiation exposure. The latter number accounts for the 200,000 emergency and recovery operation workers from 1986-1987, 116,000 evacuees, and 270,000 residents of most contaminated areas.\footnote{The Chernobyl Forum, \textit{Chernobyl’s Legacy}, supra note 138, at 5.}

These are not insignificant numbers, but they pale in comparison to other relevant events, including coal mining accidents, which kill 17 miners \textit{per day} in China\footnote{\textit{China Sets Coal Mine Accident Reduction Goal}, People's Daily Online (English), Mar. 1, 2007, at \url{http://english.people.com.cn/20070301/eng20070301_353481.html}.} and almost 50 per year in the U.S.\footnote{U.S. Dep’t of Labor, \textit{Injury Trends in Mining}, at \url{http://www.msha.gov/MSHAINFO/FactSheets/MSHAFCT2.HTM}.}

That said, both regulators and the public naturally fear that the next accident will be more serious, release more radiation, and cause more immediate and longterm deaths. Moreover, even an accident that exacts a low public health toll imposes significant other costs. “Loss of a plant costs billions of dollars and could restrict electrical generating capacity in the locality until replacement, thereby adding to the economic loss.”\footnote{MIT Study, \textit{supra} note 102, at 48.} And perhaps more significantly, for this paper at least, a serious, widely reported accident -- or even a near-miss -- could well derail efforts to revitalize the nuclear industry as a partial solution to climate change. As Professor Schrag puts it, “the impact of Chernobyl is not measured in terms of deaths …. The world got scared of nuclear power.”\footnote{Jonathan Shaw, \textit{Fueling Our Future}, \textit{supra} note 135, at 41.}

\textit{b) Proliferation}

A related risk of growing the nuclear sector is the possibility that technology proliferation could lead to weapons proliferation, either because weapons-usable material is “diverted” by a sub-national terrorist group, or because a nation that does not currently have nuclear weapons chooses to misuse its “fuel cycle facilities (including related facilities, such a research reactors or hot cells)” – and its knowledgeable nuclear engineers – to produce them.\footnote{MIT Study, \textit{supra} note 102, at 65.} To date, “[s]pent fuel discharged from power reactors worldwide contains well over 1000 tonnes (1,000,000 kg) of plutonium. With modest nuclear infrastructure, any nation could … separate the plutonium with high purity … at the scale needed to acquire material for several weapons.”\footnote{\textit{Id.} at 66.} Moreover, reprocessing facilities in

\begin{thebibliography}{99}
\item The Chernobyl Forum, \textit{Chernobyl’s Legacy}, supra note 138, at 5.
\item \textit{China Sets Coal Mine Accident Reduction Goal}, People’s Daily Online (English), Mar. 1, 2007, at \url{http://english.people.com.cn/20070301/eng20070301_353481.html}.
\item U.S. Dep’t of Labor, \textit{Injury Trends in Mining}, at \url{http://www.msha.gov/MSHAINFO/FactSheets/MSHAFCT2.HTM}.
\item MIT Study, \textit{supra} note 102, at 48.
\item Jonathan Shaw, \textit{Fueling Our Future}, \textit{supra} note 135, at 41.
\item MIT Study, \textit{supra} note 102, at 65.
\item \textit{Id.} at 66.
\end{thebibliography}
Europe, Russia, and Japan have already accumulated about 200 tonnes (200,000 kg) of separated plutonium — enough to build 25,000 weapons.\textsuperscript{148}

The risks associated with this accumulation of radioactive materials are manifest — and they grow rapidly under the various plausible scenarios for mid-century nuclear plant deployment. For example, by 2050, the “developing world might plausibly account for about a third of deployed nuclear power” and “dramatic growth of nuclear power in the sub-continent could be a pathway for nuclear arsenal expansion in India and Pakistan.”\textsuperscript{149}

c) Waste

In addition to ensuring facilities’ operational safety and limiting the threat of nuclear weapons proliferation, the nuclear industry must also safely dispose of the massive quantities of radioactive waste produced by existing and new facilities. To understand the Herculean nature of this task, one must first have a sense of the scope of the waste issue. According to DOE’s Office of Civilian Radioactive Waste Management, as of 2003, the United States had accumulated about 49,000 metric tons (108 million pounds) of spent fuel from nuclear reactors.\textsuperscript{150} Under current regulations, the Yucca Mountain storage facility could someday contain all of this waste, but Yucca Mountain would not come close to solving the waste disposal problem for the MIT Study’s proposed new plants:

A worldwide deployment of one thousand [large reactors] with today’s fuel management characteristics would generate roughly three times as much spent fuel annually as does today’s nuclear power plant fleet. If this fuel was disposed of directly, new repository storage capacity equal to the currently planned capacity of the Yucca Mountain facility would have be to created somewhere in the world roughly every three or four years. For the United States, a three-fold increase in nuclear generating capacity would create a requirement for a Yucca Mountain equivalent of storage capacity roughly every 12 years.\textsuperscript{151}

For nuclear power simply to maintain its current share of the electricity sector over the next half-century, then, the world would have to build between 11 and 15 new (and operational) “Yucca Mountains,”

\textsuperscript{148} Id.

\textsuperscript{149} Id.

\textsuperscript{150} OCRWM, DOE, Nuclear Waste Explained: How Much Nuclear Waste Is in the United States? at \url{http://www.ocrwm.doe.gov/ymp/about/howmuch.shtml}.

\textsuperscript{151} MIT Study, supra note 102, at 61.
and the United States would have to build about 4. One need only review Yucca Mountain’s pathetic history to recognize the near impossibility of this task:

- **1978:** The Department of Energy (“DOE”) began studying Yucca Mountain, Nevada, to determine its suitability to be the “nation’s first long-term geologic repository for [the] spent nuclear fuel and high-level radioactive waste … [c]urrently stored at 126 sites around the nation.”\(^{152}\)

- **1982:** Congress first directed the federal government to take responsibility for permanently disposing of the nuclear waste.\(^{153}\)

- **1984:** DOE formally identified Yucca Mountain as a potential site for a permanent geologic repository.\(^{154}\)

- **1987:** to cut down on costs and regulatory delays, Congress focused DOE’s attentions exclusively on Yucca Mountain.\(^{155}\)

- **2001 - 2002:** EPA, NRC and DOE issued health and safety standards, licensing standards, and site-suitability criteria, respectively, to govern the Yucca Mountain facility. The State of Nevada and various other groups filed suit challenging both the rules and the underlying decision to focus all federal waste disposal efforts on the Yucca Mountain site.\(^{156}\)

- **2004:** The D.C. Circuit struck down aspects of the EPA and NRC rules, holding that the agencies had no scientific basis for their use of a 10,000-year limit on radiation releases from the repository.\(^{157}\) The agencies went back to the drawing board.

- **2005:** DOE disclosed emails from geologists “indicating that some [Yucca Mountain] quality assurance documentation had been falsified.”\(^{158}\) Senator Harry Reid stated, “It should be obvious to everyone now that Yucca Mountain isn’t going


\(^{154}\) *Nuclear Energy Institute, Inc. v. EPA*, 373 F.3d 1251, 1258 (D.C. Cir. 2004).

\(^{155}\) *Id.* at 1260.

\(^{156}\) *Id.* at 1260-62.

\(^{157}\) Specifically, the court held that the agencies had no reason to select 10,000 years rather than a longer limit that would correspond more closely to the million-year “time scale of the long-term stability of the fundamental geologic regime … at Yucca Mountain.” *Id.* at 1267, 1315.

anywhere. It is abundantly clear that there is no such thing as sound science at Yucca Mountain.”

- **2006:** Secretary of Energy Samuel Bodman told members of the House Appropriations Committee that construction of the Yucca Mountain repository probably would not begin until at least 2011. DOE’s “Best-Achievable Repository Construction Schedule” indicated that the repository could not possibly begin receiving wastes for disposal until March 31, 2017.

In sum, the federal government has had its eyes on Yucca Mountain for more than a quarter century, yet it does not plan to break ground for at least 5 years, nor to begin disposing of waste until 2017 at the earliest. At that point, the project will have been in the works for 40 years. At that rate, if each of the MIT Study’s four hypothetical repositories follows a site-selection, licensing, litigation, construction, and testing schedule like that of Yucca Mountain, we should expect the fourth to open its doors well after the middle of the 22nd century.

*d) Regulatory reforms to address these risks*

Given the serious safety, proliferation, and waste problems associated with deployment of new nuclear plants, it should be clear that safe reinvigoration of the nuclear sector requires regulatory action – and, in turn, the political will to push the necessary reforms through the relevant legislatures and agencies. This paper does not attempt to list, let alone discuss, all of the reforms that experts have proposed. A brief summary of a few waste management-related suggestions suffices to make the point on which this discussion turns – namely, that if we hope to make nuclear power a safe and significant piece of our climate change strategy, we must significantly amend the regulatory landscape.

The MIT Study identifies the management and disposal of high-level radioactive waste as “one of the primary obstacles to the development of the nuclear power industry around the world.” To improve prospects for a satisfactory solution of this pressing problem, the Study urges several specific regulatory changes, including (1) “replacing the current ad hoc approach to spent fuel storage with an explicit strategy to store spent fuel for a period of several decades, prior to reprocessing [or]

---


160 CRS, Nuclear Energy Policy, supra note 133, at CRS-12.


162 MIT Study, supra note 102, at 86.
disposal”; (2) building “centralized facilities for storing spent fuel for several decades,” both in the U.S. and internationally; (3) broadening U.S. waste-related research and development efforts to encompass approaches other than permanent geologic disposal; (4) organizationally separating the research and development program from waste management operations “to resist pressures to narrow the scope of the R&D program”; (5) upping the current per-kilowatt-hour fee for waste management, both to improve the financial position of the federal waste program and to increase utilities’ incentives to develop waste minimization strategies; and (6) “actively pursu[ing] closer international coordination of standards and regulations for waste transportation, storage and disposal.”

These and other potential changes in the current regulatory regime would, in turn, pressure the relevant agencies to make additional changes, notably including updating the accounting methods and assumptions they use to estimate the adequacy of waste-related funding.

Each of these suggestions for regulatory reform may seem achievable on its face. But after close to 30 years of legal wrangling, we are still 5 years shy of breaking ground at Yucca Mountain. Imagine, then, the political and legal battles that would likely ensue if, for example, the government announced plans to build centralized facilities equipped to store high-level waste for several decades, as the MIT Study recommends. Clearly, “support for keeping the nuclear power option open … depend[s] on convincing the public and their elected representatives that large-scale deployment can overcome” the technology’s economic, safety, proliferation, and waste problems.

B. We Can’t Get There from Here

Are policymakers likely to be successful in making that case? Due to the tiered structure of the nuclear power risk, the answer is probably either “no” or “only partially”—and interestingly, there are reasons that we might prefer the former.

---

163 Id. at 85-87.

164 See, e.g., Michael A. Mullett, Financing for Eternity the Storage of Spent Nuclear Fuel: A Crisis of Law and Policy Precipitated by Electric Deregulation Will Face New President, 18 PAC ENVTL. L. REV. 383, 455-56 (2001) (“[E]lectric industry restructuring may be expected to precipitate a crisis for current law and policy, the resolution of which will require significant changes in the structure and financing of the Nuclear Waste Fund.”).

165 MIT Study, supra note 102, at 28.
1. Simple failure

The first possible outcome of any effort to “sell” nuclear power to a skeptical public is outright failure. Entrenched fears could prove resistant to even the most carefully designed education efforts.

The reasons for this are straightforward: Due to the heuristics and biases discussed above, people tend to fear nuclear power more than climate change. As Gregory N. Mandel has observed, nuclear power’s attributes “read like a laundry list of aggravating traits concerning risk. Th[is] technolog[y’y]’s risks commonly are perceived to be: dread, uncontrollable, potentially catastrophic, fatal, inequitably distributed, place future generations at risk, involuntary, not observable, unknown, new, irreversible, human created, complex, and unfamiliar.”166 In short, nuclear power occupies an “extreme position[] in psychometric factor space[.]”167 The risks of climate change, on the other hand, are less well known and less “available” to the imagination. Historically at least, people have shown little understanding of climate-related dangers, and even less willingness to take on significant costs to avoid them.168

U.S. antiproliferation rhetoric only reinforces this dichotomy. Politicians’ talk about the risk that Iran and North Korea could coopt nuclear power facilities for bomb development169 cannot but bolster current nuclear fears. To make matters worse, experts suggest that at the scale of nuclear deployment envisioned in the MIT Study, another big nuclear accident is all but certain – and such an accident, in turn, is all but certain to erase any gains in public acceptance.170

In the end, then, a large scale effort to convince the public to endorse nuclear power (whether based on the bounded rationality model or on


167 Paul Slovic, Perception of Risk 220, 229, in PERCEPTION OF RISK, supra note 3. See also Wouter Poortinga, et al., Public Perceptions of Nuclear Power, Climate Change and Energy Options in Britain: Summary Findings of survey Conducted during October and November 2005, Understanding Risk Working Paper 06-02 at 7 (2006) (“The general stigmaton, which we know is invariably attached to nuclear power, remains. Many respondents think that it creates dangerous waste (84% agree or strongly agree) and is a hazard to human health (70%).”)

168 E.g., Nancy Stauffer, Climate Change Poorly Understood, Not a High Priority, Shows MIT Public Survey (summer 2005), at http://esd.mit.edu/esd_reports/summer2005climate_change.html; Jon Palfreman, A Tale of Two Fears: Exploring Media Depictions of Nuclear Power and Global Warming, 23 REV. POL. RES. 23, 24 (2006) (detailing the results of focus groups on nuclear power and climate change and asking, “[w]hat accounts for such widely differing public attitudes?”).


170 See supra notes 135 & 145 and accompanying text.
cultural cognition) might prove a colossal waste of money. A series of memorable Katrina-like events could, of course, increase public concern about climate issues, and correspondingly increase acceptance of alternatives (possibly including nuclear power). Absent such a catastrophe, however, an education campaign may do little to reshape attitudes.\footnote{Indeed, early results of an effort to use the affirmation effect in this way have been disappointing. See Poortinga, Public Perceptions, supra note 167, at 1-2 ("A recent reanalysis of data linking the issues of climate change and radioactive waste from a national comparative survey and focus groups … shows that people do interpret nuclear energy in a different way when it is positioned alongside climate change. In effect, people in the focus groups became more ambivalent and less antagonistic about nuclear power as an energy source. Despite this, few of our participants actively and wholeheartedly supported climate change mitigation through new nuclear build as an acceptable policy position." (emphasis added)).}

2. Partial success

Unfortunately, utter failure may be preferable to the other likely outcome of such a campaign: partial success that leaves us at a regulatory deadend, with a booming nuclear industry but without the political will to push through comprehensive safety, proliferation, and waste regulations.

We could arrive at this perhaps incongruous final position in one of two ways, each of which turns on the ready division of the nuclear risk into preliminary or first-tier risks (those associated with reactor safety) and collateral or second-tier risks (those associated with mining, transport, processing, storage, and disposal of radioactive materials). The first possible consequence of this tiered structure is that second-tier risks could prove more fearsome than first-tier, either because the former trigger more or more significant perceptual biases (more dread, less well understood, etc.) or because the former are politically "hotter" and more culturally divisive.\footnote{See supra note ___ and associated text.}

For example, consider basic reactor safety (first-tier), on the one hand, and waste risks (second-tier), on the other. We are used to seeing reactors on our city skylines; they have good safety records, at least in recent years; their technology is reasonably well understood and familiar; 103 existing ones spread around the nation already supply close to 20\% of our power. In contrast, waste handling facilities present new and less well understood risks; they use unfamiliar technologies; the waste goes in tanks, pools, or underground, where we cannot see it and reassure\footnote{See supra note ___ and associated text. Wouter Poortinga, et al.’s results tend to support this dichotomy, albeit weakly: In a comprehensive empirical survey of British public opinion on future energy options for the UK, they found that 84\% of respondents feared nuclear power’s waste products, while only 70\% feared the technology itself. Poortinga, Public Perceptions, supra note 167, at 7.}
ourselves of its continued containment. Thus, people may be more fearful of waste-related issues than of reactors themselves.\textsuperscript{174}

John Weingart offers a stark account of the depth of public fear of radioactive waste sites. Director of New Jersey’s Low-Level Radioactive Waste Disposal Facility Siting Board in the 1990’s, Weingart tried to find a New Jersey community willing to host a radioactive waste facility for \textit{low-level} waste (that is, lightly contaminated waste from medical facilities and other sources, which is far less dangerous than that from nuclear power operations\textsuperscript{175}). At first, Weingart was optimistic about his chances of success. But when it came time to accept such a facility in their “backyards,” people simply could not let go of their fears:

At the Siting Board’s open houses, people would invent scenarios and then dare Board members and staff to say they were impossible. A person would ask, “What would happen if a plane crashed into a concrete bunker full of radioactive waste and exploded?” We would explain that while the plane and its contents might explode, nothing in the disposal facility could. And they would say, “But what if explosives had mistakenly been disposed of, and the monitoring devices at the facility had malfunctioned so they weren’t noticed?” We would head down the road of saying that this was an extremely unlikely set of events. And they would say, “Well, it could happen, couldn’t it?\textsuperscript{176}

Put simply, then, the public may feel a little better about new reactors than about the new waste storage, processing, and disposal facilities that those reactors necessitate. As a result, a majority could learn to accept reactor construction in cities and towns but continue to fight necessary collateral actions like siting, construction, and operation of waste storage and disposal facilities. Our present situation affords a ready example of the public’s ability to hold such seemingly incongruous beliefs: We now \textit{have} an operating (if somewhat stagnant) nuclear industry that supplies close to 20% of our power, yet we have fought tooth and nail, thus far successfully, against development of a permanent radioactive waste disposal facility. There are very real problems with the Yucca Mountain site, but nothing about that battle suggests that a more

\textsuperscript{174} See \textit{supra} note ___ and associated text.

\textsuperscript{175} See U.S. Nuclear Regulatory Commission, \textit{Low-Level Waste}, at \url{http://www.nrc.gov/waste/low-level-waste.html}.

geologically appropriate site-choice would have ensured an uncontentious licensing process.

The current situation in France provides further evidence that people can hold tight to seemingly incompatible views about nuclear power and its collateral risks. There, nuclear energy makes up more than 75% of the electric power sector, and the public largely supports the industry.\footnote{One possible explanation for this support is that the French are somewhat more hierarchical than Americans, and hence more willing to believe assurances from their leaders that nuclear power is safe. Jon Palfreman, \textit{Why the French Like Nuclear Energy}, FRONTLINE, Jul. 13 2006, at \url{http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html} ("Scientists and engineers have a much higher status in France than in America. Many high ranking civil servants and government officials trained as scientists and engineers (rather than lawyers, as in the United States), and, unlike in the U.S. … these technocrats form a special elite.").} When it came time to develop a waste facility, however, people balked. There were widespread demonstrations and even riots. And the problem has yet to be solved.\footnote{Palfreman, \textit{Why the French Like Nuclear Energy}, supra ("Things were going very well until the late 80s when another nuclear issue surfaced that threatened to derail their very successful program: nuclear waste … The same rural regions that had actively lobbied to become nuclear power plant sites were openly hostile to the idea of being selected as France’s nuclear waste dump. … There were riots.").}

The second, even more intractable impact of the tiered structure of the nuclear power risk is only relevant under the cultural cognition model. As noted above,\footnote{See supra note ___ and accompanying text.} cultural cognition theorists suggest that it may be possible to overcome public opposition to a particular policy choice by structuring policy proposals to affirm multiple groups’ worldviews simultaneously. According to this idea, policymakers could potentially make headway in the nuclear debate by expressly pushing nuclear power as part of U.S. climate policy. By affirming individualists’ and hierarchists’ positive views of nuclear power, this approach could reduce such individuals’ “political[]” and “cognitive[] … resistance … to the proposition that global warming is a problem after all.”\footnote{Cultural Cognition, supra note 29, at 169.} At the same time, “when egalitarians and solidarists are exposed to the same information, they are likely to perceive nuclear power to be less dangerous.”\footnote{\textit{Id.}}

The flaw in the ointment is that the resulting coalition is likely to support one thing and one thing only: market-based incentives for more nuclear power development. There is very little reason to think that the individualists and hierarchists will stay on this bandwagon long enough to support the necessary top-down regulatory controls for the second-tier risks of the uranium fuel cycle. Why would they? The impetus for their
support was, by assumption, their positive views of nuclear power; nothing about the affirmation effect seems likely to increase their concern about nuclear power’s side effects. Moreover, again by assumption, individualists and hierarchists are predisposed to favor market-based solutions to social problems, making them doubly unlikely to recognize a need for command-and-control waste- or proliferation-related reforms. In short, then, it may be possible to build a coalition to support industry-stimulating government programs, but that coalition is almost destined to prove unstable when confronted with nuclear power’s collateral risks.

In conclusion, then, both the bounded rationality and cultural cognition models suggest that a public education campaign about the “nuclear option” could overcome opposition to nuclear sector growth, but could well fail to build adequate support for second-tier command-and-control regimes. For all the reasons discussed above, however, significant sector growth is only safe if there is parallel regulatory progress on all levels. Thus, depending on the relative sizes of the climate change and nuclear power risks, idiosyncratic public support for the nuclear sector could actually prove harmful, leaving us worse off than under the status quo.

IV. Lessons from the Nuclear Power Debate

The debate about the role of nuclear power in our climate change strategy is concededly unique, pitting risks about which the public has sticky attitudes against risks that are diffuse, scientifically complex, and virtually impossible to quantify with any certainty. Nevertheless, the conclusions of section III have broad application both within and outside the risk context.

First, as Sunstein and others have noted, some risks are “hot.”\textsuperscript{182} They may be hot (1) because people have strong affective feelings about them, solidified by recent newspaper accounts, and made partisan by effects like group polarization and normative bias, or instead (2) because they implicate cultural predispositions. Regardless of the root cause, however, perceptions about hot risks will prove resilient to most and perhaps all efforts to shift public opinion. In particular, it may not be possible to shift opinions about a hot risk (nuclear) by making dire predictions about a “cooler” one (climate change). This is not a surprising or even a particularly thought-provoking observation, but it is worth noting, if only to temper the enthusiasm of those who blithely assume that the choice to reinvigorate the nuclear industry in response to climate change is one that regulators can make without considering public opinion.

\textsuperscript{182} Misfearing, supra note 6, at 1118.
The more interesting lesson from the nuclear power debate concerns the structure of risks. Many risks involve tradeoffs—as Sunstein puts it, “[t]here are risks on all sides of social situations.”183 Addressing the most obvious “first” risk, then, will almost always create, expose, or augment some related or derivative risk. When the underlying risk layers are of the same nature as the first, there is reason to hope that both expert and lay risk-assessors will reach some reasonable middle ground, recognizing and accepting the need to balance regulatory responses to achieve a sensible overall policy. Thus, for example, when air bags turned out to cause some deaths in car accidents, regulators were quick to realize that some people (infants in car seats and small children and adults) should be discouraged from sitting in a seat “protected” by an airbag.184 For these people, the derivative risks of the first order regulatory change (requiring airbags) proved greater than the hazard that regulation sought to correct. But because the first- and second-tier problems were similar in kind—injuries and deaths in car accidents–there was little disagreement about the proper solution: scale back the notion that all passengers should be protected by airbags. Instead, passengers of the right size and weight should be protected by airbags, while others should be protected from air bags.185

In contrast, when the first and second risk layers differ in kind—differently certain, differently controllable, differently catastrophic, triggering different normative biases, and even receiving different news coverage—there is every reason to be concerned that first-tier action will lead directly to a peculiar form of regulatory dead end—in mathematical terms, a local minimum. As discussed above, for instance, action to stimulate the nuclear industry could well lead to development of second-tier risks that trigger different public reactions. In turn, these second-tier risks could prove more intractable than the initial regulatory dilemma, leaving us frozen in a regulatory position that few would have chosen at the outset.

There is a cultural aspect to this phenomenon as well. As noted in the nuclear context, the self-affirmation effect suggests that a regulatory regime designed to provide “something for everyone” can garner support from a surprising coalition of people. Again, however, there is a problem: The coalition that learned to support the first-tier regulation could well prove unstable in the face of the second-tier risks. In this

183 LAWS OF FEAR, supra note 7, at 4.


185 Id.
case, the proximate cause of the change in majority view would not be a change in the nature of the risk (differently dread) but a change in the form of the available policy approaches (command-and-control regulation, say, rather than market incentives). Regardless of the mechanism, though, the end result is the same: Regulators who designed a first-tier regulatory regime to attract the support of a diverse majority of voters could find themselves confronting equally or more hazardous second-tier risks without the benefit of that public support.

Path dependence of this kind is ubiquitous. In 1966, for example, Alfred E. Kahn suggested the following hypothetical: Suppose, in 1880, “some being from outer space” had proposed a new “means of transportation that could ... permit you to travel about, alone or in small groups, at 60 to 80 miles an hour” at a price of 40,000 lives per year.\footnote{Alfred E. Kahn, The Tyranny of Small Decisions: Market Failures, Imperfections, and the Limits of Economics, 19 KYKLOS: INT’L REV. SOC. SCI 29-30 (1966).} In Kahn’s view, we would have found this proposal profoundly unappealing.\footnote{Id. at 30.} Yet we “reached the same result gradually, unwittingly.”\footnote{Id.} Each car purchase made the next one cheaper, easier, more appealing, and eventually more necessary, as people relied on the ubiquity of cars in making decisions about where to work and to live. At few points along this trajectory did we look back to ask whether society, as a whole, was moving in a useful direction.

Kahn does not discuss this problem in terms of risk perception, but it can be recast in that light: The first-tier risks of the automobile were relatively certain and controllable – not particularly dread, raising few cultural red-flags. Each individual could choose whether to drive a car; few people recognized the pollution costs;\footnote{Indeed, cars solved the local pollution problem of horse manure on city streets. Stephen J. Dubner & Steven D. Levitt, Freakonomics: Dog-Waste Management, N.Y. TIMES __, Oct. 2, 2005.} and accidents were fewer and less catastrophic. In short, there were many fewer fear-triggers, so people could support development of the industry. With each generation of the automobile age, however, the risks shifted subtly, until now we find ourselves confronted by automobiles that exact enormous public health tolls and, worse, exacerbate oil dependence, local and regional pollution, and atmospheric carbon-loading.

These second-tier automobile risks are different in kind, both from the first-tier risks and from each other. We may not fear cars’ immediate public health hazards as much as they warrant, but we do fear them – we call to mind injured friends and relatives and see news reports of multi-car pileups, and our resulting fear leads us to support some level of costly
regulation to address these risks (traffic signals, speed limits, side impact bars, seat belts). As a society, we are somewhat more agnostic about local and regional air pollution, which has less obviously catastrophic effects – we fear it enough to support better catalytic converters, but not enough to support regulations that would reduce miles traveled (carpooling requirements, walking streets and intercept parking, dollars to public transportation rather than road construction). And we are so complacent about the risks of climate change that we ask, in all seriousness, whether carbon dioxide from cars and other sources should be considered an air pollutant.\(^{190}\) Overall, then, society’s differing attitudes toward the different layers of automobile risks have produced a largely incoherent regulatory regime that does next to nothing to protect us from some of the most significant automobile hazards.

The automobile example hinges on the triggering of different perceptual biases at different steps along the regulatory chain, but examples of the related problem of coalition instability abound as well. For instance, different cultural attitudes toward drug use (widely derogated) and urban blight (of greater concern to egalitarians and solidarists than to others) have left us with a national drug policy that cracks down on users and dealers without addressing any of the social ills created by a policy of imprisonment.\(^{191}\) Very similar dynamics led to the “deinstitutionalization of individuals with mental and physical handicaps” and the subsequent failure to construct the residential group homes that were supposed to replace large institutions.\(^{192}\) In the context of choice, the coalitions that champion state abortion restrictions sometimes break down when they are asked to support second-tier reforms like improved counseling for pregnant women, streamlined adoption procedures, and social and economic support networks for single mothers.\(^{193}\) And similar coalition instability helps to explain why

---

\(^{190}\) Massachusetts v. EPA, case no. 05-1120 (argued Nov. 29, 2006).

\(^{191}\) See, e.g., Erik Luna, Drug Exceptionalism, 47 VILLANOVA L. REV. 753, 796 (2002) (“[T]he brunt of [drug-war] violence is shouldered by those who are least able to bear the costs: poor, largely urban and minority communities. … With the flight of human and financial capital away from urban blight, these communities are left totally devastated by the drug war.”).

\(^{192}\) Kevin J. Zanner, Dispersion Requirements for the Siting of Group Homes: Reconciling New York’s Padavan Law with the Fair Housing Amendments Act of 1988, 44 BUFFALO L. REV. 249, 249 (1996) (noting that “[m]unicipalities and siting agencies have struggled to integrate these individuals into residential communities, often encountering the familiar cry of ‘not in my backyard’”).

\(^{193}\) See, e.g., Nadine Strossen, Women’s Rights under Siege, 73 N.D. LAW. REV. 207, 228 (1997) (“[T]he ‘Contract with the American Family,’ and many members of Congress who support[ed] it, [sought to deny] low-income women … any funding for abortions, even if their pregnancies resulted from rape or incest. … Ironically, though, under the welfare ‘reform’ proposals supported by some of the very same organizations and individuals, many poor women are denied any funding for the babies to whom they give birth.”). But see Kahan and Braman, Cultural
political parties that must pander to multiple interest groups to win elections subsequently have difficulty governing;\textsuperscript{194} why interracial coalitions that have lobbied for slavery reparations disagree on remedy (college funds versus bail funds);\textsuperscript{195} and why the school voucher movement faltered when it adopted a goal of racial justice in place of its early emphasis on values-based education.\textsuperscript{196}

In short, multilayered regulatory dilemmas are common, and local “regulatory minima” – undesirable policy dead-ends from which policymakers cannot emerge because the political dynamics changed unexpectedly between the first and second tiers of the regulatory effort – are ubiquitous. In the risk context however, the problem is particularly acute, because risk perception theorists are actively trying to use behavioral psychology insights to sway public opinion. In this context, it is especially important to consider the consequences of any such education strategy. Failure to do so could produce an entrenched and irrational regulatory policy that addresses first-tier risks but leaves us threatened by equally or more serious second-tier risks that defy regulatory solution.

V. Conclusion

Public risk perceptions could play an important role in the eventual resolution of the debate about whether to build hundreds or thousands of new nuclear power plants in response to climate change. The public’s antipathy for all things nuclear could defeat any effort either (1) to persuade former opponents to support growth of the nuclear sector, or (2) to build a coalition of odd bedfellows willing – each for their own reasons, and some reluctantly – to agree to that growth. Alternatively, such an effort could have mixed results, increasing public support for a first round of market-based regulatory changes to facilitate sector growth (for example, tax credits and liability guarantees), but failing to shift opinion about the command-and-control regulations necessary to address second-tier risks, including those associated with radioactive waste.

\textit{Cognition, supra} note 29 at 166 (suggesting that in France, the affirmation effect resulted in the success of some first- and second-tier efforts to address unwanted pregnancies).

\textsuperscript{194} \textit{See, e.g.}, Ryan Sager, \textit{The Elephant in the Room: Evangelicals, Libertarians, and the Battle to Control the Republican Party} (2006) (“[A] s the South has become central to Republican Party strategy, its particular flavor of social conservatism, moral certitude, and activist government has infused the national party's character. This is slowly alienating the other major bloc in the Republican coalition: small-government conservatives, especially those who value individual liberty most highly.”).


transport, processing, and storage. The latter scenario would deposit us at the closed end of a regulatory blind alley, unable to delicense the new power plants, but also unable satisfactorily to address their collateral safety and public health risks.

This last unexpected and unfortunate outcome results from a little-discussed attribute of the regulatory process: Regulating risk is a tiered exercise. Often, an unintended consequence of the first set of regulatory changes is the exposure or augmentation of new risks that require their own round of regulatory solution. As for the principal risk, the likelihood that policymakers will be successful in addressing each of these new risks hinges, in part, on public support for a regulatory solution. And such public support depends tightly on the nature of the risk (is it particularly dread?) and on the nature of the required solution (appropriate for a market-based approach or better suited to command-and-control regulation?).

This wedding-cake or onion-peel view of risk and regulation has important implications for those who would use behavioral psychology insights to shift public opinion about existing risks. In brief: Watch what you wish for. That such approaches could fail altogether turns out to be the good news. Far worse is partial success, which can build support for first-tier regulatory reforms that expose or augment equally or more serious second-tier risks less amenable to regulatory solutions.